CURRENT STATUS OF REPRODUCTIVE BIOTECHNOLOGIES
IN LIVESTOCK BREEDING
IN INDONESIA

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ABSTRACT
Reproductive biotechnology such as artificial insemination (AI) and embryo transfer (ET) has become a
powerful tool in improvement of genetics and production of livestock animals. In Indonesia, as one of developing
countries, faces a challenge to increase the productivity of livestock animals. However, success rate of this
technology varies among studies and areas. Although ET as the second generation of reproductive biotechnology
has also been introduced and ET station was established, more ET stations are needed to produce more embryos.
Improvement of conception rate after AI and ET is important to increase livestock production in Indonesia and
finally to meet the demand of the people.

Keywords: Reproductive biotechnology, artificial insemination, embryo transfer, Indonesia

INTRODUCTION
The use of reproductive biotechnologies especially artificial insemination (AI) and embryo transfer (ET) in cattle
industry has widely been applied in many farms in developed countries. Since these reproductive biotechnologies
were found to improve genetics and production of livestock animals, these were spread out rapidly and slowly to
all over the world both in developed and developing countries and Indonesia is no exception. In Indonesia, as one
of developing countries, the use of these biotechnologies faces a challenge to increase the productivity of animals
especially for beef production to meet the need for food as human population increases rapidly (Anonymous,
2009). Madan (2005) reported that the developing world is grossly unprepared for the new technological and
economic opportunities, challenges, and risks that lie on the horizon. Moreover, he mentioned that livestock
production is globally growing faster than any other sectors and by 2020 livestock is predicted to become the
most important agricultural sector in terms of value adding, and that the role of biotechnology will lead to a
distinct shift in the economic returns from livestock. Therefore, it is necessary to establish and to apply the
biotechnology, especially reproductive biotechnology, to meet the challenges in livestock animal and beef
production for the need of human population.

In Indonesia, the human population was about 215,276,000 in 2007 with growth rate of approximately 1.5 per
year (Tappa, 2012). Figure 1 shows the human population in Indonesia during a period of 1971 to 2010. This
population will increase and it is predicted to achieve 273 million in 2025 (Tappa, 2012; Statistics Indonesia,
2015). This condition will be a new challenge for animal production, which is not only to maintain but also to
increase beef production for food, while the land area for the animals has been decreasing gradually resulting in
the decrease in the population of large animals (cattle and buffalo) (Figure 2) because of increased land for
housing as human population increases (Figures 1). In fact, Figure 3 shows that the number of slaughtered large
animals (cattle and buffalo) in Indonesia during seven years (2007 – 2013) period was relatively flattened. If this
condition continues, it will probably result in reduced meat consumption in Indonesia in the future. Therefore, it would
be wise to accelerate the improvement of livestock production in many ways.

One of the methods that are believed to accelerate maintaining the livestock production is the use and application
of reproductive biotechnology in a wide range of and/or intensively to the producers/farmers. Kahi and Rewe
(2008) stated that biotechnology is important if the world is to respond to the pressure to produce more food from
livestock animals according to the ever-growing human population. Furthermore, it was suggested that biotechnological approaches can be employed for improving productivity, economy, and physicochemical and nutritional attributes of a wide range of livestock products (Gupta and Savalia, 2012). In most developing countries, biotechnological applications related with livestock production need to be suitable for animal owners who are mainly resource-poor small-scale operators owning little or no land and few animals (Madan, 2005). Therefore, it is necessary to apply and to use biotechnology in order to improve and to increase livestock production especially in Indonesia.

Figure 1. Human population of Indonesia from 1971 to 2010 (Statistics Indonesia, 2015).

Figure 2. Population of large livestock animals (cattle and buffalo) in Indonesia from 2010 to 2014 (Statistics Indonesia, 2015).
Figure 3. Number of large livestock animals (cattle and buffalo) slaughtered in Indonesia from 2007 to 2013 (Statistics Indonesia, 2015).

STATUS OF AI AND OTHER REPRODUCTIVE BIOTECHNOLOGIES

In Indonesia, AI was first introduced by Prof. B. Seith (Denmark) in 1953 (Tappa, 2012). The method used to inseminate the animals at that time was with the help of vaginoscopy to locate the semen (chilled semen) in the female reproductive tract. This method was subsequently adapted and developed for twenty years (1953 – 1973) known as period for introducing AI. This method resulted in a low conception rate, approximately 20-30% (Tappa, 2012; Toelihere, 2004). In 1973, frozen semen was first imported and introduced in Indonesia (Tappa, 2012). Due to the fact that the use of home-made frozen semen is more efficient in applying AI rather than chilled semen or imported frozen semen, the government of Indonesia in cooperation with the government of New Zealand decided to produce frozen semen in Indonesia. As a result, the first AI station was developed in Lembang, West Java in 1976 followed by AI station in Singosari, Malang, East Java in 1982/1983. Nowadays, several small AI stations have been developed in many areas in Indonesia.

Since AI station was established in Indonesia, semen production has been also increased every year. The first AI station in Indonesia (BIB Lembang) has produced semen straws as shown in Figure 4 (Source: BIB Lembang, 2013). From 1976 to 2013, semen production in this AI station was fluctuating. During a period from 1984/1985 to 1990/1991 semen production tended to decrease and eventually reached a peak in 1991 to 1994 and again decreased in subsequent years till 1997/1998. However, since 2003 the production of semen straws increased gradually and reached 2,453,281 straws in 2012 (Figure 4) from all bulls (175) at different breeds including 18 dairy bulls, 157 beef bulls (Ongole, Brahman, Simmental, Limousine, Brangus, and Madura) and some bucks. In 2013, this AI station distributed approximately 1,457,168 semen straws or about 66.8% of total production (2,182,984) (Figure 4) to several provinces and producers in Indonesia.

The second AI station in Indonesia (BBIB Singosari) has produced and distributed semen straws during a period of 2007 – 2012 as shown in Figure 5. Basically, semen straw production and distribution in this AI station increased every year reaching peak in 2010. To our knowledge, there is no accumulated data available nationally to show success of application of AI in Indonesia. However, several reports have shown different success rates of this technology in the field. Reproductive performance of the cows at different breeds has been reported by Singosari AI station (2012) as shown in Table 1 (Maidaswar, 2013). Data in this table were obtained only in East Java. High reproductive performance of the cows and fertility of the bulls in this report are the hope for improvement of genetics as well as production in cattle.
Table 1. Conception rate and service per conception of the cows artificially inseminated using frozen semen from bulls with different breeds

<table>
<thead>
<tr>
<th>Breed of the Bull</th>
<th>Conception rate (%)</th>
<th>Service per conception (S/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brahman</td>
<td>72.4</td>
<td>1.33</td>
</tr>
<tr>
<td>Ongole</td>
<td>73.1</td>
<td>1.32</td>
</tr>
<tr>
<td>Madura</td>
<td>73.5</td>
<td>1.36</td>
</tr>
<tr>
<td>Simmental</td>
<td>73.2</td>
<td>1.36</td>
</tr>
<tr>
<td>Limousine</td>
<td>73.5</td>
<td>1.36</td>
</tr>
<tr>
<td>FH</td>
<td>71.7</td>
<td>1.43</td>
</tr>
</tbody>
</table>

Reproductive performance of the cows after AI monitored using radioimmunoassay (RIA) technique at two provinces in Indonesia (Tjiptosumirat et al., 2007) is shown in Table 2. Differences between reproductive performances of the cows after AI in two reports (Tables 1 and 2) were not fully understood. However, a higher conception rate and better S/C in Table 1 than those in Table 2 might be explained by the well-selected cows and intensive AI used in the report having Table 1.

Table 2. Conception rate and service per conception of the cows after AI at different provinces in Indonesia, monitored using radioimmunoassay (RIA) technique

<table>
<thead>
<tr>
<th>Province</th>
<th>Variable</th>
<th>Conception rate (%)</th>
<th>Service per conception (S/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Sumatra</td>
<td>AI Technician 1</td>
<td>31.0</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>AI Technician 2</td>
<td>34.0</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>31.3</td>
<td>3.2</td>
</tr>
<tr>
<td>South Sulawesi</td>
<td>Control</td>
<td>27.1</td>
<td>na</td>
</tr>
<tr>
<td></td>
<td>Treated with UMMB</td>
<td>49.2</td>
<td>na</td>
</tr>
</tbody>
</table>

UMMB = Urea molasses multi nutrient block

Likewise, ET as the second generation of reproductive biotechnology was also introduced in Indonesia; as a result, ET station (Balai Embryo Ternak), was established in Cipelang, West Java to accommodate both bulls and cows with genetically high quality. This ET station has about 650 cows both for donors and recipients of embryos and produces approximately 600 to 700 embryos by both in-vivo and in-vitro methods per year (Kompas, 2015). In 2014 it produced 750 embryos and distributed them to several areas in Indonesia. Since this ET station established in 1991, it has distributed 183 bulls and 373 heifers/cows which had been obtained by ET at the station, and 9,132 embryos to all over Indonesia till 2014.

Figure 4. Semen straw production in Lembang AI station (BBIB Lembang)
Another reproductive biotechnology that is now developing in Indonesia is sexing of semen for AI. Lembang AI station has produced 2,511 straws of sexed semen consisting of 1,302, 719, and 490 straws (FH, Simmental and Limousine, respectively) in 2013. Similarly, Singosari AI station has also produced 2,100 X-bearing sperm of FH in 2012. However, we have no data regarding the fate of this sexed semen especially their contribution on reproductive performance of the cows after AI. Nevertheless, a study using sexed semen in Bali cattle has been reported by Said et al. (2014); the overall conception rate after AI in their study was 59.2% (148/250). This conception rate consisted of 44.1% (67/152) for the cows treated with PGF$_{2\alpha}$ injection to induce estrous and 82.7% (81/98) for the cows showing estrous naturally. Moreover, the results of this study also confirmed that out of 100 cows inseminated using X-bearing sperms, 94% had desired female calves in Farm 1. Similar result was obtained in Farm 2 (93.8%; n=48). Another study with small size of cows has been conducted using Ongole crossbreed (Susilawati, 2005). The overall rate of desired sex obtained in this study was 81.5% (n=27); this consisted of 91.7% (n=12) Y-bearing sperms resulted in male calves and 73.3% (n=15) X-bearing sperms resulted infemale calves. These two studies suggested that the use of sexed semen was important in production of offspring with desired sex. However, more efforts are needed to apply and use this biotechnology in a wide range in Indonesia.

Several reasons why sexed semen is more important today than ever before (Anonymous, 2015):

a) A growing population, particularly in the developing world coupled with changing dietary habits had resulted in the global demand for milk and other dairy products growing daily. No longer is over supply forcing prices down, the opposite is true with supply not able to keep up with ever increasing demand.

b) Replacement heifer prices are all the time high across the world, with farms expanding in an attempt to meet the global demand for milk.

c) The demand for beef from the dairy herd is high with buyers seeking top quality crossbred calves rather than Holstein bull calves.

d) Animal health and welfare continue to rise as a priority at consumer, supermarket and government levels; making easy calving heifers is a high priority.

**PROSPECT**

Since the use of reproductive biotechnology in cattle is intended to improve and to increase genetics and production of animals, this technology in this country will be promising for the future. For instance, beef and buffalo beef that consumed by the people of Indonesia is increasing every year (Tappa, 2012) as shown in Table 3. During three years period from 1999 to 2002, beef and buffalo beef consumption was increased 11,261,000 kg or 3.16% from 355,864,000 kg to 367,125,000 kg. Likewise, from 2002 to 2006 the consumption was also increased 57,854,000 kg.
### Table 3. Beef and buffalo beef consumption in Indonesia

<table>
<thead>
<tr>
<th>Year</th>
<th>Beef and buffalo beef consumption (kg)</th>
<th>Increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>355,864,000</td>
<td>-</td>
</tr>
<tr>
<td>2002</td>
<td>367,125,000</td>
<td>3.16</td>
</tr>
<tr>
<td>2006</td>
<td>424,979,000</td>
<td>15.76</td>
</tr>
<tr>
<td>2015</td>
<td>505,597,000*</td>
<td>18.97</td>
</tr>
</tbody>
</table>

*Predicted

In Table 3, the need for beef and buffalo beef for consumption in Indonesia in 2015 is predicted to be 505,597,000 kg. However, the capability of the producer in the country to meet the need is only about 435,000,000 kg/year (Statistics Indonesia, 2014). The remaining beef should be imported from outside of Indonesia. This means that Indonesia through producers/farmers has to produce more beef and buffalo beef by raising cattle and buffalo effectively. To achieve high effectiveness of raising cattle and buffalo, it is necessary to manage them by involving all resources that support their development including reproductive management especially the use of reproductive biotechnology. This is reasonable because as shown in Figure 6, population of dairy cattle, beef cattle and buffalo is relatively flattened and likely decreasing.

### PROBLEMS

It has been stated that to achieve high reproductive efficiency in cattle, the cows should have calving interval in a year (Peter and Ball, 1987). In Indonesia, reproductive performance of the cows is relatively poor; it is characterized by high service per conception (>2), low conception rate <70%, long calving interval >16 mo, and long estrus postpartum >90 d (Tappa, 2012). Study of Tjiptosumirat et al. (2007) reported that conception rate of the cows in several places in Indonesia was relatively poor; mainly lower than 40%. In dairy cows, our case study confirmed that the incidence of repeat breeding was relatively high (62%) (Yusuf et al., 2012). Although this study also confirmed that days in milk at first AI in repeat breeding cows was relatively similar to the normal fertility (60.4±15.2 d vs. 68.3±28.6 d), their calving to conception interval and service per conception were differ significantly (222.9±134.1 d vs. 123.3±52.9 d and 4.8±0.9 vs. 2.4±0.8). Although causes of this repeat breeding are usually unclear, environmental, management and animal factors might be involved (Katagiri and Takahashi, 2004). However, high incidence of repeat breeding in our study (Yusuf et al., 2012) might be caused by technical aspect such as poor insemination technique or handling semen at the time of AI. Therefore, it is necessary to find out the exact causes to solve problems, and finally we have to increase the reproductive performance of the cows.

![Figure 6. Cattle and buffalo population in Indonesia during five years period (2010 – 2014).](image-url)
CONCLUSION

As one of reproductive biotechnologies in livestock breeding in Indonesia AI was introduced more than 50 years ago. Success rate of this technology varies among studies and areas. Although ET as the second generation of reproductive biotechnology has also been introduced and ET station was established, more ET stations are needed to produce more embryos. Improvement of conception rate after AI and ET is important to increase livestock production in Indonesia and finally to meet the demand of the people.

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REFERENCES


